Contribution to the anatomy of the sinus maxillaris in Central-European skulls

AUTHOR(S):

FARKA, L. G.; FEIGLOVÁ, B.; HAJNI, K.; KUSTRA, T.

CITATION:

FARKA, L. G. ...[et al]. Contribution to the anatomy of the sinus maxillaris in Central-European skulls. 日本外科宝函 1966, 35(6): 1054-1065

ISSUE DATE:

1966-11-01

URL:

http://hdl.handle.net/2433/207341

Contribution to the anatomy of the sinus maxillaris in Central-European skulls

by

L. G. FARKAŠ and B. FEIGLOVÁ

Laboratory for Plastic Surgery of the Čs. Academy of Sciences at Prague
(Head: Prof. Dr. V. Karfikí Dr. Sc.)

K. HAJNIŠ

Cathedra of Anthropology, Charles University at Prague
(Head: Prof. V. Fetter, C. Sc)

T. KUSTRA

ORL Department, Inst. of Nat. Health at Martin
(Head: Dr. T.Kustra)

Received for Publication Aug. 31, 1966

For practical reasons it is necessary to know the whole size and outline of the sinus maxillaris, its shape and relations to neighbouring organs and structures, which often may be located in a mutually unfavorable position causing many pathologic states.

Data quoted in literature on the sinus maxillaris are often contradictory and are copied from work to work. They usually were gained from radiologic examinations of the maxillary sinus.

In order to define anatomical pecularities of the sinus maxillaris with greater exactitude we started an exploration of this cavity on skulls.

MATERIAL AND METHOD

We used a total or 114 maxillae, belonging to 90 individuals for this research, 58 left ones and 56 right ones. The material was gained from collections belonging to the Anthropologic Institute of Charles University at Prague. Our series is not classified as to the sexes, because in the majority of cases we used such parts of the splanchnocranium on which it was not possible to determine any pecularitis of sex.

The particular details of the sinus maxillaris were determined metrically and by aspect. We registered metrically:

1) The width, height and depth of the cavity

2) The height of the medial wall below the insertion of the concha nasalis inferior to the base of the nasal meatus

3) The thickness of all bony walls of the sinus (upper, anterior, posterior and medial one)

4) The relation of the antral floor to the base of the nasal meatus

5) The minimal and maximal distances of the single roots P_2-M_3 from the floor of the sinus and the participation of the particular teeth in the developing perforation of its floor

6) The main dimensions of the body of the maxilla (width, height and depth) similarly as for the sinus.

However the height of the body of the maxilla was measured together with the recessus alveolaris for the reason, that the observed dimensions of the maxilla were correlated with values measured of its sinus, which as we know - is in its height still further enlarged by the recessus alveolaris, which is very frequently present as could also be confirmed by our study. Where it was possible also the width of the meatus nasi and the aperturae piriformis and the deviation of the vomer were measured.

In all cases a movable gauge was used for the measuring.

The following unmeasurable criteria of the antrum Highmori were ascertained by aspect :

1) Asymmetry as to volume and shape in cases where these were clearly visible
2) Incidence (number) and size of bony septa in the maxillary sinus
3) Incidence of recessi
4) Connection of the sinus with the canalis infraorbitalis

For unmeasurable valuse only their percentual incidence was ascertained. For total assessment of measurable values we calculated in the usual way (See E. Weber 1957, K. Hrubý 1961) their arithmetical means ($\bar{x}$) and its mean error ($s_{\bar{x}}$), standard deviation (s) and variation coefficient (v). In the tables they are queted together with the number of cases used (n) and the minimal and maximal occurring value (min-max), separately of course for the left and for the right side. The correlation coefficients were gained by the method of Bravais. Beside values of the correlation coefficient (r) we also quote its mean error (s_r) calculated according to the equation

$$s_r = \sqrt{\frac{1-r^2}{n-2}} \qquad \text{(K. Hrubý 1961).}$$

MAIN DIMENSIONS OF THE BODY OF THE MAXILLA AND OF THE SINUS MAXILLARIS AND THEIR RELATIONS. THICKNESS OF THE WALLS OF THE SINUS MAXILLARIS

Looking at table 1 it is apparent that there is practically no difference between the left side and the right one, which was also confirmed by the t-test calculated for the differences, the values of which however we do not quote.

It may be derived from the table that a maxilla with a body of about $27 \times 41.5 \times 46$ mm in size may be considered bilaterally as the average of our series, and that it has a sinus measuring on average $23.5 \times 29.5 \times 36$ mm.

Table 2 gives average values, minimal and maximal values occurring and further statistic characteristics of the thickness of the bony walls of the sinus maxillaris. A statistically significant difference between the right and the left side is found in all cases for the thickness of the antral wall, except for the posterior wall, where the difference is statistically only conclusive (t-test = 2.45). The highest t-test in our series was found for

the differences in the thickness of the medial wall on the left and on the right as 8.11, even if the absolute difference of calculated mean values is only 0.06 mm. The t-test for the difference in the thickness of the upper wall is 3.24, of the anterior wall 4.47.

From table 2 it is apparent, that the antral wall is thickest on average in the anterior part, but the same measures were found, or only slightly thinner ones also for the posterior wall. The thinnest of all walls of the sinus maxillaris are the median walls.

Inspite of the fact, that we measured with an accuracy of 0.1 mm certain errors must undoubtedly have occurred during the measuring because of the low absolute values of the thickness of the antral walls. Together with the considerable variability of the thickness of all walls this fact is obviously the reason for the highly significant deviations and the very high variation coefficients obtained for the thickness of all walls of the sinus maxillaris (see table 2).

We did not find any mutual relations between the thickness of the median wall of the antrum and the width of the corpus maxillae, nor between the height of the corpus maxillae and the alveolar recessus. In a similar way also no relation was found between the thickness of the anterior wall of the antrum and both quoted criteria (see table 3).

Tab. 1 Average values of basic dimensions of maxillary corpus and maxillary sinus.

		left side					right eide				
		n	$\bar{x}\pm3\cdot s_{\bar{x}}$	s	v	min-max	n	$\bar{x}\pm3\cdot s_{\bar{x}}$	s	v	min-max
maxillary corpus	width	49	26.93±3・0.63	4.40	15.92	19–39	47	27.71±3・0.73	5.02	18.11	19–47.5
	height (+alveolar process)	33	41.50±3・0.63	3.63	8.74	34–53	32	41.62±3・0.60	3.40	8.16	34–47
	depth	41	46.34±3・0.45	2.88	6.21	39.5–52	38	46.10±3・0.68	4.20	9.11	39.5–53
maxillary sinus	width	37	23.47±3・0.78	4.79	20.40	12–33	36	23.58±3・0.92	5.57	23.62	9.5–33
	height	35	29.78±3・1.05	6.23	20.92	18–41	30	29.40±3・1.04	5.70	19.38	18–41
	depth	44	35.77±3・0.52	3.46	9.67	28.5–42	42	36.19±3・0.49	3.23	8.92	30–42

Tab. 2 Average values of thickness of the bony walls of maxillary sinus.

	Left side					right side				
wall	n	$\bar{x}\pm3\cdot s_{\bar{x}}$	s	v	minim.–maximal	n	$\bar{x}\pm3\cdot s_{\bar{x}}$	s	v	minim.–maximal
upper (superior)	35	0.98±3・0.06	0.40	40.81	0.2–2.0	32	0.89±3・0.07	0.45	50.56	0.4–2.0
medial	58	0.74±3・0.03	0.28	37.83	0.2–1.5	56	0.8±3・60.03	0.24	35.29	0.3–1.5
posterior	51	1.06±3・0.05	0.42	39.62	0.3–2.4	45	1.09±3・0.05	0.37	33.94	0.3–1.8
frontal (anterior)	51	1.19±3・0.05	0.40	33.61	0.5–1.8	48	1.09±3・0.05	0.39	35.77	0.5–2.2

Tab. 3 Correlative coefficients between certain traced signs.

The sign	n	r	s_r
The width of maxillary corpus – the width of maxillary sinus	70	0.027	0.119
The height of maxillary corpus and alveolar processus the height of mavillary sinus	58	0.234	0.129
The depth of maxillary corpus – the depth of maxillary sinus	72	0.258	0.115
The width of maxillary corpus the thickness of the medial wall of maxillary einus	94	– 0.047	0.104
The height of maxjllary corpus and alveolar processus the thickness of the anterior wall of maxillary sinus	65	0.041	0.125
The width of maxillary corpus the thickness of the anterior wall of mavillary sinus	81	0.141	0.111
The height of maxillary corpus and alveolar processus the thickness of the anterior wall of maxillary sinus	52	0.078	0.140
The width of nasal meatus the width of maxillary sinus	26	– 0.309	0.194
The width of piriform aperture – the width of naeal meatus	24	0.266	0.205

RECESSI AND SEPTA SINUS MAXILLARIS. HEIGHT OF MEDIAN WALL BELOW THE INSERTION OF THE CONCHA NASALIS INFERIOR

It is apparent from table 4, that there are no differences as to sides in the height of the medial wall, but that there exists a high individual variability for this criterion, which influenced the high value of standard deviation and of the variation coefficient. The calculated average value compared with the range of variation for this criterion proves, that the majority of cases is concentrated around the upper limit of the quoted variability, that means, that the height of the medial wall of the antrum Highmori below the insertion of the inferior nasal concha is about 20 mm, which comes within the upper limit stated by J. Lajda (1961). This dimension is indicating the height of the nasal muco-periostal flap with we usually cover the antral orifice of an antro-oral fistula according to the method of one of us (T. Kustra, A. Misík 1965).

Tab. 4 The average values of the height of medial wall of maxillary sinus under the insertion of interior nasal concha and width of nasal passage.

The height of the wall	n	$z \pm 3 \cdot s_x$	s	v	minim. –maximal
Left side	26	$19.53 \pm 3 \cdot 0.52$	2.68	13.72	12–23
Right side	25	$19.56 \pm 3 \cdot 0.61$	3.07	15.69	12–23
Width of the nasal meatus	24	$30.75 \pm 3 \cdot 0.82$	4.05	13.17	23–42

The recessus palatinus is undoubtedly one of the least frequently occurring antral recessi to be registered on aspect. In our series it was found equally for the left and the right side only in not a total of 2 %, which is in agreement with findings of G. Portman (1951), even if in about 10% cases we were not able to assess its presence for both sides. According to table 5 it is apparent, that the recessus alveolaris is the most frequently found one of all recessi in men and may be found in about one half of all individuals.

Tab. 5 The appearance of alheolar recesus, palatinus, zypomaticus and frontalis.

Recessus		n	present		absent		undiscovered	
			n	%	n	%	n	%
alveolaris	sin	58	31	53.44	21	36.20	6	10.34
	dx	55	26	47.27	24	43.63	5	9.09
palatinus	sin	58	1	1.72	51	87.93	6	10.34
	dx	55	1	1.81	48	87.27	6	10.90
zygomaticus	sin	58	25	43.10	15	25.86	18	31.03
	dx	55	22	40.00	11	20.00	22	40.00
frontalis	sin	58	23	39.65	20	34.48	15	25.86
	dx	55	23	41.81	17	30.90	15	27.27

The recessus frontalis and recessus zygomaticus appear in our series about equally frequently, that is around 40 %. However we think, that with regard to the large part of material, where it was not possible to assess the presence of both these recessi (see table 5) the mentioned data are lesser than the two foregoing ones.

Recessi of the antrum Highmori may be of various sizes. A recessus of excessive dimensions may weaken the sinus walls. Table 6 gives the number of bony septa and their outlines in the maxillary sinus in our series. The incidence of medium high crests dividing partially the space of the antrum Highmori is by no means a rare one, as may be seen from the table. Especially the occurrence of one medium high septum is relatively frequent according to our findings. Less frequently are found two or especially more medium high bony septa in the sinus maxillaris (the maximal number found by us was four). Only in two individuals we found one complete septum, one on the left side and one on the right one. In slightly more than a half of the sinuses we found bilaterally no signs of any bony septum.

Tab. 6 The number and extent of the bony dartitions of maxillary sinus.

		1 demi-hetght	2 demi-height	3 demi-height	4 demi-height	1 total	without partition
sin	n	16	4	3	1	1	33
(n = 58)	%	27.58	6.89	5.17	1.72	1.72	56.89
dx	n	19	5	1	—	1	29
(n = 55)	%	34.54	9.09	1.81	—	1.81	52.72

ASYMMETRY OF THE SINUS MAXILLARIS AND ITS CONNECTION WITH THE CANALIS INFRAORBITALIS

Some authors (f. e. J. Lajda 1961) are of the opinion, that the antral cavities are usually symmetric ones. This contention is being opposed not only by our findings, demonstrated on table 7, but also by observations quoted by I. J. Temkinová (1952), W. Jankowski, A. Wanke, H. Szcotka, Z. Ziemski, R. Marciniak (1959) and by others.

Our observations of the sinus maxillaris with regard to asymmetries in volume and shape are only visual ones and it is therefore very likely, that especially asymmetries in

Tab. 7 Asymmetry of maxillary sinus.

	present		absent		undiscovered	
	n	%	n	%	n	%
shaped	25	83.33	1	3.33	4	13.33
voluminous	20	66.66	2	6.66	8	26.66

volume will be still more frequent than as they are shown on our table 7.

From the prectical point of view is the question of frequency of incidence of a direct connection of the antrum Highmori with the infraorbital canal also of great interest. Part of the canal wall, which with its convexity is bulging into the maxillary sinus is under normal conditions rather thin and may sometimes be even defective or be completely missing. In this case the infraorbital bundle of nerves and vessels is covered only by the thin muco-periosteum of the antrum. Due to the effect of various pathologic processes the infraorbital nerve may be denuded and become sensitive to external influences. B. Kuniak (1956) described such a pathologico-anatomical picture. For radical operations of the antrum it is also recommended to carry out any curettement of the mucosa on the infraorbital canal with great care to avoid any injury to the thin wall. In the mentioned way neuralgic pain persisting after operative interventions or in pathologic states of the antrum may be explained.

Table 8 shows, that in a considerable number of maxillae at our disposal we could not assess the question of an opening of the canalis infraorbitalis into the maxillary sinus because of the damaged state of this part of the wall of the sinus. The actual percentages of incidence of a connection in cases of really existing canals are given on table 8 in bracelets (sin-29, dx-24).

Tab. 8 Communication between the infraorbital canal and maxillary sinus.

n	present			absent		undiscovered	
	n	%		n	%	n	%
sin 53	1	1.88	(4.16)	23	43.39	29	54.71
dx 57	2	3.50	(6.89)	27	47.36	28	49.12

RELATION OF THE FLOOR LEVEL OF THE SINUS MAXILLARIS AND THE MEATUS NASI COMMUNIS

For surgical treatment of antro-oral fistulae it is of special importance to know the relation of the antral floor to the level of the ground of the common nasal meatus.

It may be derived from table 9 that there are two kinds of possible relations between the floor of the antrum Highmori and the meatus nasi occurring most frequently. The case seen most often of all is where the floor of the sinus maxillaris is found in the same horizontal level with the floor of the meatus nasi (27.78 %). Only somewhat lees frequently is the floor of the sinus maxillaris located deep below the level of the base of the meatus nasi (25.56 %). All other combinations of relation between the floors of both cavities, as they are quoted on table 9, are considerably less frequent. Worth mentioning

Tab. 9 Relations between the situation of the bottom of maxillary sinus and the bottom of nasal meatus.

		n	%
1	The bottom of maxillary sinus is situated deeply below the bottom of nasal mestus	23	25.56
2	The bottom of maxillary sinus is situated slightly below the bottom of nasal meatus	8	8.89
3	The maxillary sinus is situated to the right, lower than simply to the right side however both are found below the bottom of nasal cavity	3	3.33
4	The maxillary sinus is situated to the left lower than to the right – however both are found below the bottom of nasal cavity	4	4.45
5	The bottom of maxillary sinus is found on the same level as the bottom of nasal meatus	25	27.78
6	The bottom of maxillary sinus is situated higher than the bottom of nasal meatus	5	5.56
7	The bottom of the left maxillary sinus is found below the bottom of the right cavity at the same level as the bottom of nasal meatus	3	3.33
8	The anterior half of the maxillary sinus bottom's is found lower and the posterior half at the same level as the bottom of nasal meatus	11	12.22
9	The anterior half of the maxillary sinus bottom's is found above, whereas the posterior half below the nasal meatus	1	1.11
10	The anterior third of the maxillary sinus bottom's is situated lower, wherens the two remaining thirds are found at the same level as the bottom of nasal meatus	1	1.11
11	The anterior third of maxillary sinus bottom's is situated lower than the central third at the same level and the posterior third above the bottom of nasal meatus	1	1.11
12	The anterior third of the maxillary sinus bottom' is found at the same level, the central third lower and the posterior third at the same level as the bottom of nasal meatus	3	3.33
13	The anterior two thirds of the maxillary sinus are situated lower, whereas the posterior third above the bottom of nasal meatus	1	1.11
14	The anterior quarter of maxillary sinus is situated at the same level, the central two quarters below and the posterior quarter again at the same level as nasal meatus bottom	1	1.11
		90	100.00

is only one further case, where the anterior half of the antral floor is lying below the level of the base of the nasal meatus, the posterior half at the same level (12.22 %) and where the whole floor of the sinus maxillaris is lying slightly below the level of the base of the meatus nasi (8.89 %).

Relatively rarely there are also sinuses with their floors variously divided in relation to the base of the nasal meatus, as it is demonstrated on table 9, figure 9 to 14. Rather surprising is the on the whole low percentage of maxillary sinuses with their floors lying above the level of the ground of the meatus nasi (5.56 %). Our numbers are even smaller than those of L. I. Sverjevskij (cited acc. to A. G. Lichatshev, B. S. Preobrajenskij and J. S. Temkin, 1951), who is quoting an incidence of this combination in 17.9 %. The

same author is also stating the incidence of deep sinuses reaching below the level of the base of the nasal meatus with 42.8 %, whereas he found the floors of both cavities in horizontal levels only in 39.3 % of cases. The frequency of incidence of the last two possibilities therefore is in the material of L. I. Sverjevskij appearing in reversed order as compared with our series.

DEVIATION OF VOMER

Assessment of the position of the vomer was possible only in 20 cases because of damage to the skulls. In half of this number we found deviation of the vomer to the left side, in three cases to the right side and seven vomers kept to the median line. The small number of observations does not allow for any generally valid conclusions.

CRO-ANTRAL FISTULAE

The fact that the roots of the posterior teeth of the upper posterior arch may protrude into the sinus maxillaris has been pointed out already 300 years ago by Nathaniel Highmore (cited acc, to Ph. Reading et al., 1955). And Parfitt and Herbert (cited acc. to Ph. Reading, D. F. N. Harrison, R. C. W. Dinsdale 1955) state, that 2 % of all teeth which they extracted had had some contact with the muco-periosteum of the antrum.

In the further we present a survey according to data from literature of teeth lying in the closest vicinity of the antrum :

L. Petrovits (1928/9) : M_3

H. N. Boyne (1926) : M_2

A. G. Lichatshev et al. (1951) : M_1-M_2-P_2 (with decreasing frequency to the right side)

D. F. N. Harrison (1961) : M_2-M_3-M_1-P_2-P_1 (with decreasing frequency to the right)

T. Kustra (1965) suggests that the thickness of the bony septa between the sinus maxillaris and the alveoli of the teeth located underneath is depending upon the age and upon the varying level of the antral floor with regard to the base of the nasal cavity.

In order to gain more knowledge on the relation between the roots of the distally located teeth to the floor of the sinus maxillaris we measured the thickness of bony septa between the floor and the dental alveoli P_2-M_3. For this reason we selected two larger groups out of our series. The first one comprises maxillae with the floor of their sinus maxillaris located deep below the base of the nasal meatus, the second one maxillad with the floor of their maxillary sinus practically at level with the base of the nasal meatus.

Average, minimal and maximal thickness of bony partitions in deeply located antra are given on table 10, those with the antral floor at level with the base of the nasal meatus are on table 11.

From table 10 it is to be seen that the bony partition separating the dental alveoli P_2-M_3 may have in all cases an almost lamellar character. Contrarily in sinuses with a higher located floor at the same level with the base of the nasal meatus, these partitions may beside lamellar ones be also thicker, as it is demonstrated on table 11, reaching a thickness of up to 2 mm. Also the measured maximal thickness is usually considerably larger in higher located maxillary sinuses than in deeply located ones, as may be derived

Tab. 10 The average, minimal and maximal distances of dental roots P_2–M_3 from the bottom of maxillary sinus, which is deeply below the leuel of nasal meatus.

	The root	P_2		M_1						M_2						M_3	
				buccal				palatinal		buccal				palatinal		palatinal	
				proximal		distal				proximal		distal					
	side	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin
The thickness of the bottom of maxillary sinus above dental apex in mm	minimal thickness	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	maximal thickness	3.5	2.5	L	3.5	1	3.5	2.5	5.5	L	L	2	1	2	2	3.5	1
	average value	1.8	1.2	L	1.2	0.3	1.5	1.2	1.5	L	L	0.7	0.3	1	0.9	1.3	0.2

Footnote: L-lamellous thickness of the bottom of antrum

Tab. 11 The distance of the dental roots P_2–M_3 from the bottom of maxillary sinus, which is situated at the same level as the bottom of nasal meatus.

	The root	P_2		M_1						M_2						M_3	
				buccal				palatinal		buccal				palatinal		palatinal	
				proximal		distal				proximal		distal					
	side	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin	dx	sin
The thickness of the bottom of maxillary sinus above dental apex in mm	minimal thickness	0.5	0.3	L	L	L	0.5	L	L	L	2	L	1.5	L	L	L	L
	maximal thickness	4	4	6	5	6	6	9	8	L	6	4	7	7	4.5	12	12
	average value	2.5	2.4	2.1	2	2.3	2.5	2.9	2.5	L	4	1.8	3.7	2.6	2.2	4.5	4.1

Footnote: L-lamellous thickness of the bottom of antrum.

from comparison of the two mentioned tables. We want to draw attention especailly to the very thick septum, which may be found between the antrum Highmori and the roots of the third molar tooth. On the other hand we never found a partition thicker than a lamellar one (paper thin) in deeply located sinuses on the left and on the right against the buccal proximal root of M_2 and the same against the proximal buccal root of M_1 on the right in this type of maxillary sinus (see table 10).

Average values of thickness of bony septa between the dental alveoli and the sinus maxillaris are for this reason obviously by far higher in higher located sinuses, i.e. with their floors at the level of the base of the nasal meatus, than in deeply located sinuses.

Comparing both tables (10, 11) it becomes on the whole apparent, that the thickness of bony septa between dental alveoli and the antrum Highmori is to a large extent depending on the height of the position of the maxillary sinus. In this way the depth of the antral floor is acquiring great prognostic value. The thinnest (lamellar) septum on average was found above the mentioned roots M_2 and M_1 with deep location of the maxillary

sinus. The thickest septum on average, as mentioned, was found above the third molar tooth (4.5 mm, 4.1 mm) with the antral floor at the level of the base of the nasal meatus. Data given on tables 10 and 11 may contribute and be practically applied not only in surgery of the sinus maxillaris, but also in dental surgery. They should be used as guidance for the degree of caution in dental extractions. In some cases dental roots may be already originally in such a position that they may have direct contact with the mucoperiosteum of the maxillary sinus. In other cases the root may protrude into the antrum with its apex, or it may perforate the floor sideways (that is in a larger surface).

In the whole of our series we found (for both sides) in 58 cases a perforation of the floor of the maxillary sinus. Taking into consideration that the floor of the antrum Highmori may be perforated by the roots P_2-M_3, and that - as has been proved by our study - for molar teeth this applies for their buccal as well as palatinal roots, the mentioned 58 cases correspond to 5.07 % of the total of 114 explored floors of maxillary sinuses (58 on the left and 56 on the right) (each may be perforated by 10 roots).

Tab. 12 The share of individual teeth on the origine of perforation of maxillary sinus bottom's.

		n	%
1.	M_1	25	2.19
2.	M_2	23	2.01
3.	M_3	6	0.52
4.	P_2	4	0.35
total		58	5.07

Table 12 demonstrates the participation of the various kinds of the mentioned teeth (P_2-M_3) in the development of the quoted 58 perforations of the sinus maxillaris in our series. As is to be seen from it, the most frequenent perforation of the floor of the maxillary sinus in our series of explorations was caused by the roots of the first molar tooth. Only slightly less frequent were the roots of the second molar tooth engaged in the perforation. The remaining two teeth (M_3, P_2) perforate the floor of the antrum Highmori only rarely.

Among the mentioned number of fistulae that developed between the dental alveoli and the sinus maxillaris we found only 2 cases, where the root protruded freely into the sinus Highmori.

Again for purely practical reasons we also wanted to find out the number of perforations of the floor of the maxillary sinus in its varying location with regard to the base of the nasal meatus. The demonstrated distribution on table 13 indicates, that perfora-

Tab. 13 Appearance of perforations of maxillary sinus bottom's at their various levels with regard to the bottom of nasal meatus.

Tooth	Maxillary sinus' bottom at the level of nasal cavity	Maxillary sinus' bottom below the level of nasal cavity	Various levels of the maxillary sinus levels on both sides	Other types of antral levels in relation to the nasal cavity's bottom
P_2	—	2	1	1
M_1	1	14	6	4
M_2	1	12	7	3
M_3	—	3	1	2
n	2	31	15	10
%	0.17	2.72	1.31	0.87

tions of the antral floor occur by far more frequently if it is located below the level of the base of the nasal cavity. This group comprises more than one half - 31 - out of the mentioned 58 perforations, i.e. 2.72 % out of the total number or theoretically possible 1140 ones (114 sinuses × 10 roots). 15 cases of perforations (1.31 %) were found in cases with a different level of both halves of the antral floors and even fewer perforations in cases with other relations of the floors of both cavities. Perforations in cases of equal levels of the floor of the sinus maxillaris and of the nasal cavity is rare, as could be also proved by our observations. In cases with a high location of the sinus maxillaris, that means with its floor above the level of the base of the nasal cavity, we never found any perforation.

SUMMARY

From our exploration of the sinus maxillaris and from comparison of data thereof with literature may be derived:

1) The average size of the sinus maxillaris without difference as to sides is about 23.5 × 29.5 × 36.0 mm (width × height × depth). The corresponding average size of the maxilla is about 27 × 41.5 × 46 mm.

2) The thinnest wall on average of the sinus maxillaris is the medial one showing on the left an average value of 0.74 ± 3 • 0.03 mm and on the right 0.68 ± 3 • 0.03 mm. The difference is statistically highly significant, in the same way this applies also for the remaining antral walls, except the posterior one, where the difference is only statistically conclusive.

3) There is no relation between the size of the sinus maxillaris and the dimensions of the body of the maxilla, similarly as between the main dimensions of the body of the maxilla and the thickness of its antrum (see table 3).

4) The average value for the height of the medial wall of the antrum Highmori below the insertion of the concha nasalis inferior—which is important for surgical reasons—amounts to 19-53 ± 3,0.52 mm on the left and 19.56 ± 3,0.61 mm on the right. The variability of height is a rather considerable one, amounting from 12 up to 23 mm.

5) Of all recessi of the sinus maxillaris the most frequently occurring one is the recessus alveolaris found in about 50 % of all cases. About 40 % of maxillae have a clearly visible recessus zygomaticus and frontalis. The recessus palatinus appears only very rarely (see table 5).

6) In about 30 % of cases one medium high bony septum was found in the antrum Highmori. Greater numbers of incomplete septa or complete ones are found only rarely (see table 6).

7) In almost all cases asymmetries of the sinus maxillaris in volume and shape are to be found (table 7).

8) A connection from the canalis infraorbitalis to the antrum Highmori occurs only infrequently (table 8).

9) Most frequently a sinus maxillaris is found having the floor at the level of the base of the nasal cavity (27.78 %). But frequent are also cases having the floor of the sinus maxillaris deep below the level of the nasal cavity (25.56 %). Other possibilities of location of the floor of the sinus maxillaris with regard to the base of the nasal cavity

are fewer (table 9).

10) From the small number of cases which could be evaluated it is apparent, that the vomer is deviated more often to the left (12.34 %) than to the right (3.70 %).

11) A larger average thickness of the bony lamella between the dental alveoli P_2-M_3 and the sinus maxillaris is found in maxillae, where the floor of antrum Highmori is lying at the level of the base of the nasal cavity than in maxillae with a deeply lodated antrum (see tables 10 and 11).

12) The floor of the antrum Highmori may be perforated by dental roots P_2-M_3. M_1 is participating most frequently in the formation of these fistulae (2.19 %), then follows M_2 (2.01 %). M_3 and P_2 are the cause of oro-antral fistulae less frequently (see table 12).

13) The floor of the sinus Highmori is usually perforated by dental roots P_2-M_3, most often in those cases, where it is located deep below the level of the base of the nasal cavity. Oro-antral fistulae are rarely seen, where the floor of the maxillary sinus is at the level of the base of the nasal cavity (see table 13).

14) Out of 1140 possible cases perforation of the floor of the maxillary sinus was found in 58 antra, that is in 5.07 %.

15) Protrusion of a dental root into the sinus maxillaris was found in two cases.

LITERATURE

1) Boyne, H. N. : A study of 43 maxillary sinuses. J. Amer. Dent. Assoc. **18**. 1 : 134-156. 1926.
2) Harrison, D. F. N. : Oro-antral fistulae. -Brit, J. clin. pract. **15** : 169-174. 1961.
3) Highmore, N. : cit. acc. to Reading, Ph., D. F. N. Harrison, R. C. W. Dinsdale, 1955.
4) Hrubý, K., 1961 : Genetics. CSAV. Prague.
5) Jankowski, W., A. Wanke, H. Szcozotka, Z, Ziemski, R. Marciniak, : Z. antropologii zatoki szczekowej., Otolaryng. Polska. **13**. : 7-14. 1959.
6) Kuniak, B. : personal information 1956.
7) Kustra, T. : Some anatomic observations on the sinus maxillaris, gained by craniometric research and their application in surgery. -Bratislava med. J. **45** : 274-281. 1965
8) Kustra, T., A. Mišík, : Pierwsze doniesienia 0 chirurgicznym leczeniu przetok zatokowo-zebodolowych metod Kustry. Otolaryng. Polska. **19**. : 345-351. 1965.
9) Lajda, J. : Surgery of the nose and nasal sinuses and the nasopharynx, SAS. Bratislava. 1961.
10) Parfitt and Herbert, : cit. acc. to Ph. Reading, D. F. N. Harrison, R. C. W. Dinsdale, 1955.
11) Petrovits, L. : Substantia ossea sino interalveolaris. Anat. Anz., **66** : 115-124. 1928/29.
12) Portman, G. : Traité de technique operatoire oto-rhino-laryngologique. Masson et Cie. Paris. 1951.
13) Temkina, I. J. : Ob osložnenijach pri prekole verchnecčljustnoj pazuchy. Vestnik oto-rhino-laryngoligii, **14**. : 40-45. 1952.
14) Reading, Ph., D. F. N. Harrison, R. C. W. Dinsdale, : The causation, pathology and treatment of oro-ansral fistula resulting from dental extraction. J. Laryng. Otol. **69** : 729-743. 1955.
15) Sverjevskij, L. I. : cit. acc. to Lichatshev, A. G., B. S. Preobrazenskij, J. S. Temkin, : Fül-orr-gégé betegségek. S. 212-218. Tankönyvkiado' Budapest. 1951'
16) Weber, E. : Grundriss der biologischen Statitstik. G. Fischer. Jena. 1957.